Quality Assurance Project Plan (QAPP)

Appendix 3.2

Korea Testing & Research Institute

Quality Assurance Project Plan (QAPP)

for

Korea Testing & Research Institute (KTR)

In relation to the testing of the Kwang San Co., Ltd. “BioViolet™” BWM System for Type Approval by the government in accordance with the Procedure for Approval of Ballast Water Management Systems that Make Use of Active Substances (G9)

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Korean Marine Equipment Research Institute(KOMERI)
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February 2011

Introduction & Background

Kwang San Co., Ltd. Busan, Republic of Korea is seeking Type Approval from the government for its proprietary UV system brand called “BioViolet™” BWM System.

Such approval is being sought in accordance with the IMO **Procedure for Approval of Ballast Water Management Systems that Make Active Substances (G9)**, as adopted by Resolution MEPC 169 (57) (2008) and Resolution MEPC 174(58)(2008) of the IMO Marine Environment Protection Committee (MEPC).

Section 4.2.4 of the G9 Procedure requires that the testing process for the ballast water management system should include both a Quality Management Plan (QMP) - which addresses the overall quality management policies and structures of the test organization and a Quality Assurance Project Plan (QAPP) - which provides detailed quality assurance arrangements for the actual testing procedures.

This QAPP was made out for “BioViolet™” BWM System approval according to G9 Procedure, EPA QAPP Guideline, KOMERI QAPP and KTR's KOLAS Manual, Procedure and direction documents.

•. US EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5)

•. US EPA Guidance for Quality Assurance Project Plans (EPA QA/G-5)

•. KOMERI QAPP Rev.1.0, May 2008

•. KTR KOLAS Manual, Procedure and direction documents, 2009

Korea Testing & Research Institute (KTR)

Laboratories at the Korea Testing & Research Institute (KTR) comply with the Korean Laboratory Accreditation Scheme (KOLAS − www.kolas.go.kr) system for laboratory and research organizations: as outlined in Korean national regulations, to ensure the consistency and reliability of laboratory testing results.

All testing and analytical procedures and equipment at KTR are certified by the KOLAS to KS ISO/IEC 17025 standard. The certification number for KTR is KT073 and a copy of the current KOLAS accreditation is attached as Appendix 3.5.3.
(http://152.99.46.44/WebApp/Main/Search/Search0010.aspx?CompanyNo=3547&AccreditNo=3856&BigID=02)

Appendix 3.5.3. KOLAS certification (ISO/IEC 17025) (Certification number - KT073)

The KOLAS accreditation of KTR conforms to the overall QMP for all of its testing activities relating to the “BioViolet™” BWM System.

Quality Statement

Study Title	Testing of "BioViolet™" BWM System
Test Number	2011 - TBU – 264-277
Client	Korean Marine Equipment Research Institute(KOMERI) 1125-22 Dongsam-dong, Youngdo-gu, Busan, Republic of Korea Tel. 82-51-400-5143/Fax. 82-51-400-5191, www.komeri.re.kr
Test Facility	Korea Testing & Research Institute (KTR) 411 Dawoon-dong, Joong-gu, Ulsan, Republic of Korea Representative : Won-Tae, Choi Tel. 82-52-220-3100/Fax. 82-52-220-3001, www.ktr.or.kr

The testing and quality assurance procedures described in this Quality Assurance Project Plan (QAPP) are based on Standard Operating Procedures (SOPs) of Korea Testing & Research Institute (KTR). The accreditation gives the customer a warranty that KTR laboratories use analytical procedures according to internationally acknowledged quality systems (KS ISO/IEC 17025)

Signature date 28 February 2011

Won-Tae, Choi
Test Facility management
Korea Testing & Research Institute

"BioViolet™"

Approval Sheet

Project Management
Name : Young-Woo, Lee
Position : Chief Technology Officer
Organization : Kwang San Co., Ltd.

(Signature) 28 February 2011

Project Director (Co-worker)
Name : Young-Soo, Kim
Position : Director
Organization : KOMERI

(Signature) 28 February 2011

Project Officer
Name : Won-Tae, Choi
Position : President of KTR Yeongnam branch
Organization : KTR

(Signature) 28 February 2011

Project Director
Name : Sung-Uk, Lee
Position : Team Director
Organization : KTR

(Signature) 28 February 2011

Study Director
Name : Sun-Chool, Hwang
Position : Senior Researcher
Organization : KTR

(Signature) 28 February 2011

Quality Assurance Management
Name : Sung-Wook, Pyo
Position : Team Director
Organization : KTR

(Signature) 28 February 2011

Reviewer
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Position : Team Director
Organization : KTR

(Signature) 28 February 2011

Analysts
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Position: Senior Researcher
Organization: KTR

(Signature) 28 February 2011

Name : Ji-Hyun, Lee
Position : Senior Researcher
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(Signature) 28 February 2011

Name : Sun-Chool, Hwang
Position : Senior Researcher
Organization : KTR

(Signature) 28 February 2011

Name : Jin-Hoon, Do
Position : Researcher
Organization : KTR

(Signature) 28 February 2011

Name : Jun-Ho, Park
Position : Researcher
Organization : KTR

(Signature) 28 February 2011

Distribution List

Following is a list of key individuals and their organization to which copies of the approved Korea Testing & Research Institute (KTR) QAPP and subsequent revisions will be provided:

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Table of Contents

1. Project management

1.1 Project Description

1.1.1 Objectives of the QAPP

This QAPP describes the implementation of quality assurance and quality control activities during the evaluation of the "BioViolet™" BWM System according to the requirements for chemical testing stated in the IMO Revised Procedure for Approval of Ballast Water Treatment Systems (MEPC 53/24/Add.1, Annex 4, 2005) and Revised Guidelines for Approval of Ballast Water Management Systems (MEPC 57/WP.5, Annex 3, 2008). The requirements involve all parts and processes of the test as listed in:

Revised Procedure for approval of ballast water management system that make use of active substances (G9, MEPC 57/WP.5)

"3.3 Any system which makes use of, or generates, Active Substances, Relevant Chemicals or free radicals during the treatment process to eliminate organisms in order to comply with the Convention should be subject to this Procedure."

Stock-taking Workshop on the Activity of the GESAMP-Ballast Water Working Group Note by the Secretariat (MEPC 58/23, 2009)

"**Introduction** 5. The Workshop identified a list of more than 70 by-products which have been formed during the treatment by various ballast water management systems. Based on this, the Workshop identified, as a first step, 18 by-products believed to pose a potential risk to the environment as well as to humans being exposed, as the remaining chemicals were usually under their detection limits. The Workshop agreed to explore the possibility of asking GESAMP WG 1 (the GESAMP EHS Group) to develop hazard profiles for those chemicals. The Workshop was of the view that once developed, those hazard profiles could be used both by the applicants and the GESAMP-BWWG to significantly facilitate the process and consequently increase the number of evaluations per meeting. The list of by-products for which hazard profiles need to be developed and the properties to be evaluated for each product are set out at annexes 1 and 2 of this document.

The QAPP is a mean to reveal any problems before start-up and during execution of the project at as early stage as possible to minimize any potential procedural, technical and scientific inadequacies and time and economic losses. This QAPP will be used for chemical testing in accordance with the IMO guidelines as well as for the final and basic approval testing of active substances.

1.1.2 QAPP of KTR

Project activities were defined in a laboratory QAPP that was prepared by the Study Director and Project Manager, and reviewed by the management. The QAPP specified the work to be performed, the analytical methods to be followed, the measurement quality objectives to be achieved, and level of data review. All sample collection, transfer, storage, preparation, analyses and reporting procedures followed written Standard Operation Procedures (SOP) and test methods. Project staff members were responsible for following these procedures and guarantying that measurement quality objectives were achieved. An independent QC chemist reviewed all sample preparation and analytical documentation for completeness and accuracy and conducted full error checking of reported project data. As possible, The Project Manager was responsible for guarantying that project objectives were met and that the data were traceable and defensible.

1.2 Project Organization and Responsibilities

The overall Project Organization for the G9 testing is summarized in Figure 1.

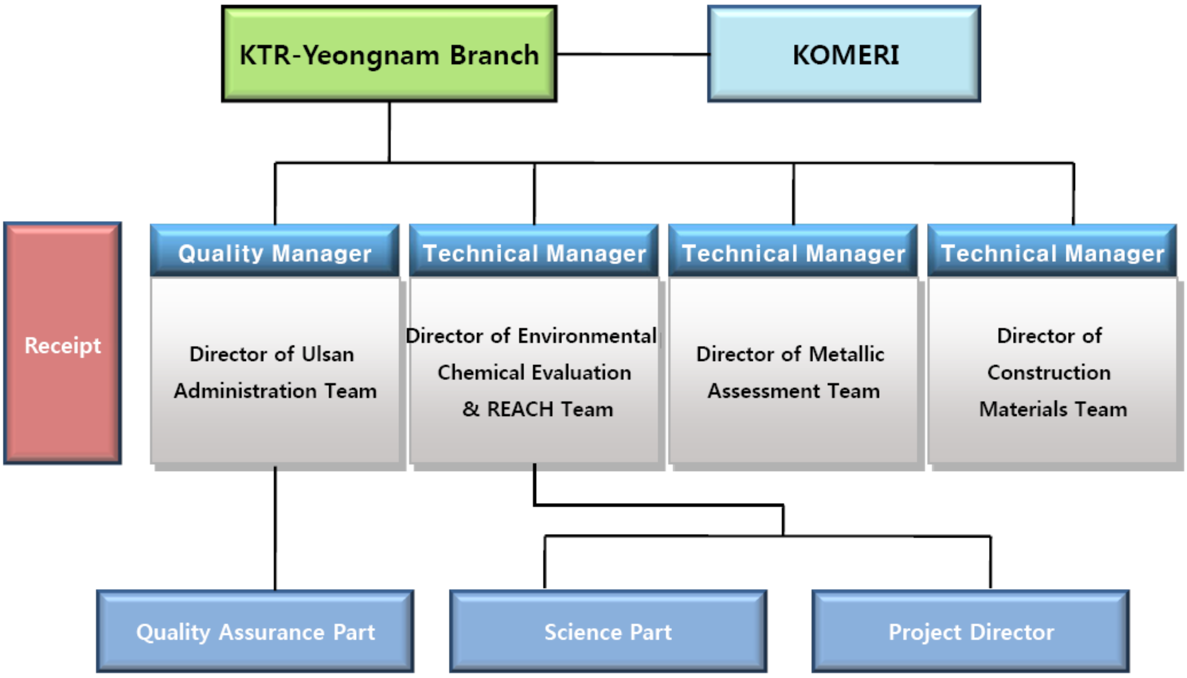

Figure 1. Organizational chart describes in outline the relationship between parties involved in this project.

- Project Officer

The project Officer, Mr. Won-Tae Choi, will oversee the project. Mr. Won-tae Choi will be responsible for Quality Assurance part (include QMP) and Technical part.

- Project Director

The project director, Mr. Sung-Uk Lee, will oversee the project. Mr. Sung-Uk Lee will be responsible for chemical water quality (DOC/POC, THMs, Halogenated Phenols HAAs, HANs etc. and water quality) and chemical water quality sample delivery to KTR laboratory.

- Study Director

This project is directly by Sun-Chool Hwang from the KTR. The project director is responsible for budgeting, all communications with the KOMERI and Kwang San Co., Ltd. coordination with the Environmental Chemical Evalution & REACH Team and supervision of data archiving.

- Science(field sampling/analytical laboratory) part

The Science part consists of all investigators receiving support from this project.

- Quality Assurance Part

Quality Assurance Manager is responsible for performing technical audit on all data.

1.3 Project and Task Description

1.3.1 Test Site

Address : Land-based test facility located at Fishery Science Technology Center, Donghwa-ri, Hail-myeon, Goseong-gun, Gyeongsangnam-do, Republic of Korea.

Photograph 1. Photo of "BioViolet™" BWM System

1.3.2 The "BioViolet™" BWM System

•. Process description

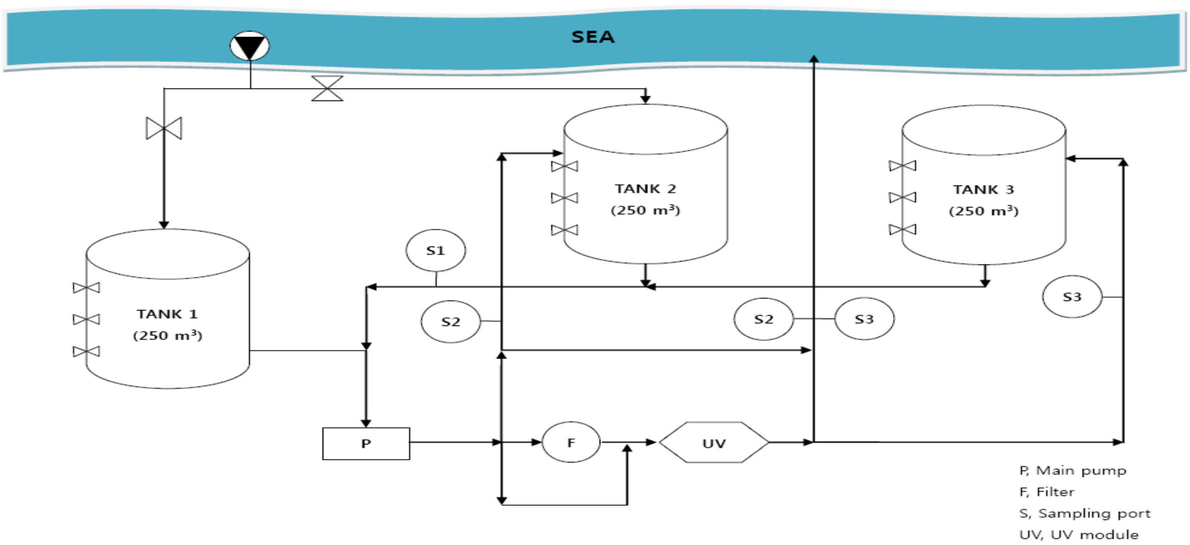

Figure 2. BioViolet™ ; Position of sampling.

1.3.3 Test Schedule

Table 1. Test Schedule

Condition	Period	Sampling date	Sampling point/tank/Name	Sample tag	KTR receipt No.
3-32 PSU	0 day	2011.10.05	Test Water	KSU-S1D0-3	TBU-264
			Control Water	KSU-S2MD0-3	TBU-265
			Treated Water	KSU-S3MD0-3	TBU-266
	1 day	2011.10.06	Control Water	KSU-S2D1-3	TBU-267
			Treated Water	KSU-S3D1-3	TBU-268
	5 day	2011.10.10	Control Water	KSU-S2MD5-3	TBU-269
			Treated Water	KSU-S3MD5-3	TBU-270
>32 PSU	0 day	2011.10.26	Test Water	KSU-S1D0-6	TBU-271
			Control Water	KSU-S2MD0-6	TBU-272
			Treated Water	KSU-S3MD0-6	TBU-273
	1 day	2011.10.27	Control Water	KSU-S2D1-6	TBU-274
			Treated Water	KSU-S3D1-6	TBU-275
	5 day	2011.10.31	Control Water	KSU-S2MD5-6	TBU-276
			Treated Water	KSU-S3MD5-6	TBU-277

* Applied Tag information ;

KSU : BioViolet™
S1-S3 : Sampling location
D0-5 : Day
-3 : Salinity 3-32, -6 : > 3 PSU

1.4 Quality Assurance Objectives

Quality assurance objectives & Procedure for the KTR Laboratory listed in Figure 3, Table 2. Individual research/study/ test projects may develop QA objectives that will supersede the objectives listed here. it is objected to validate results by writing SOPs to assure the reliability of the test results. QA/QC aim to report all analytical procedures from sampling to results and validation factors during analysis procedure are corresponding linearity and range, accuracy and precision, and the detection limit and quantitation limit. Given data generally followed specified test methods.

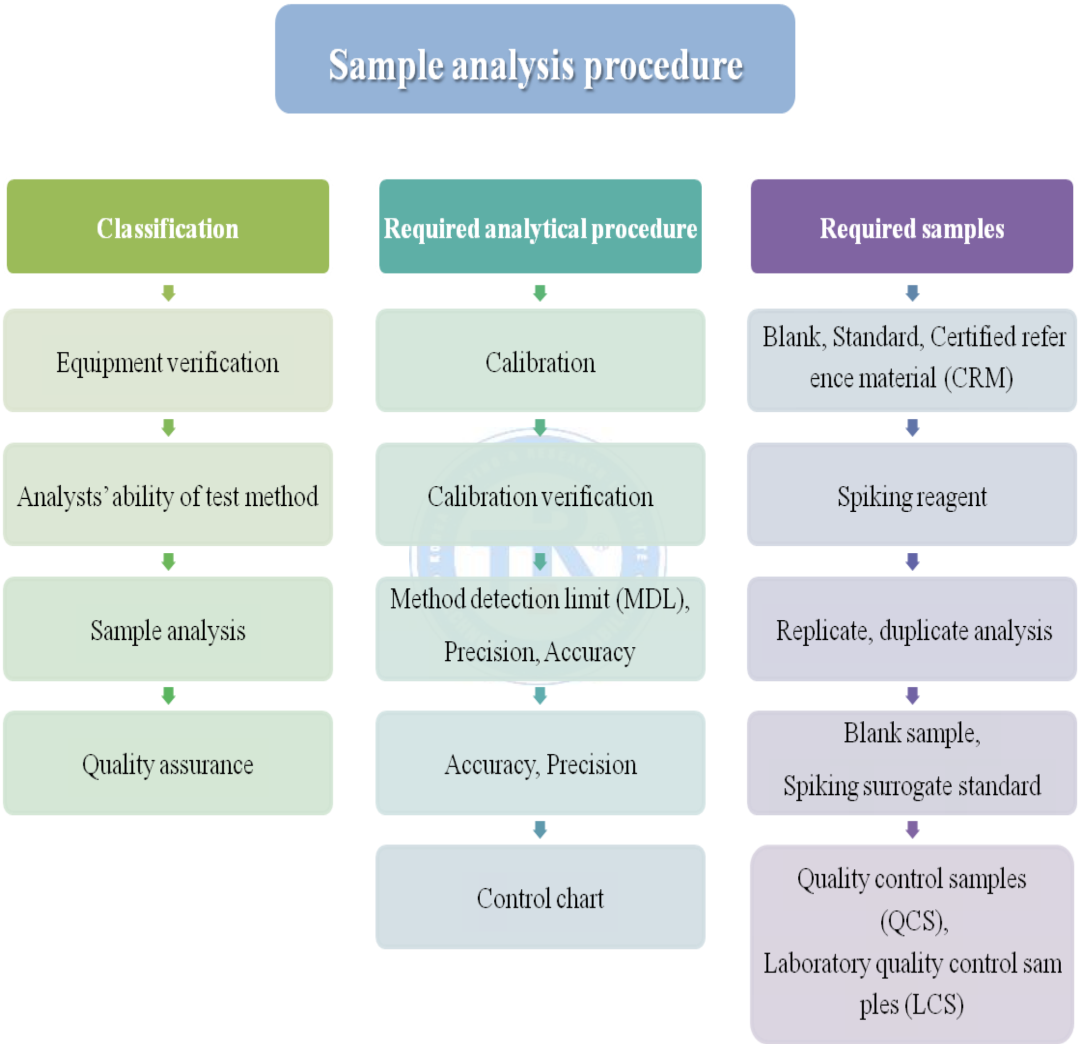

Figure 3. Procedure for quality assurance of analysis result.

Table 2. The result of validation data

Analysis item	unit	Method Detection Limit[1]	Calibration Range[2]	Precision Objective[3]	Accuracy Objective[4]
TRO	mg/L	0.03	0 - 10.0	NA[5]	NA
FRO	mg/L	0.03	0 - 10.0	NA	NA
Ozone(O_3)	mg/L	0.13	NA	NA	NA
ClO_2	mg/L	0.02	NA	NA	NA
Sulfide(S^{-2})	mg/L	0.02	NA	NA	NA
Bromate (BrO_3^-)	µg/L	0.08	5 - 100	0.56	105
Bromide(Br^-)	mg/L	0.01	1 - 10.0	0.34	96.0
Chlorate(ClO_3)	mg/L	0.09	1 - 10.0	0.45	94.0
AOX	mg/L	-	NA	NA	NA
DOC	mg/L	0.08	0 - 10.0	0.3	103
POC	mg/L	0.08	0 - 10.0	0.3	103
1,1-Dichloroethene	µg/L	0.02	1 - 500	0.2	100
Dichloromethane	µg/L	0.02	1 - 500	0.2	100
trans-1,2-Dichloroethene	µg/L	0.01	1 - 500	0.1	100
1,1-Dichloroethane	µg/L	0.01	1 - 500	0.1	100
cis-1,2-Dichloroethene	µg/L	0.01	1 - 500	0.1	100
Bromochloromethane	µg/L	0.01	1 - 500	0.2	100
Trichloromethane	µg/L	0.01	1 - 500	0.1	100
1,2-Dichloroethane	µg/L	0.01	1 - 500	0.2	100
1,1,1-Trichloroethane	µg/L	0.01	1 - 500	0.2	100
Tetrachloromethane	µg/L	0.01	1 - 500	0.2	100
Dibromomethane	µg/L	0.05	1-500	0.2	100
1,2-Dichloropropane	µg/L	0.02	1 - 500	0.2	101
Dichlorobromomethane	µg/L	0.02	1 - 500	0.2	100
1,1,2-Trichloroethane	µg/L	0.01	1 - 500	0.1	100
Dibromochloromethane	µg/L	0.01	1 - 500	0.2	100
Tetrachloroethene	µg/L	0.01	1 - 500	0.2	100
1,1,1,2-Tetrachloroethane	µg/L	0.01	1 - 500	0.1	100
1,2,3-Trichloropropane	µg/L	0.02	1 - 500	0.3	101
Chlorobenzene	µg/L	0.01	1 - 500	0.3	100
Tribromomethane	µg/L	0.03	1 - 500	0.1	101

1,1,2,2-Tetrachloroethane	μg/L	0.02	1 - 500	0.2	100
Bromobenzene	μg/L	0.01	1 - 500	0.2	100
2-Chlorotoluene	μg/L	0.02	1 - 500	0.1	100
4-Chlorotoluene	μg/L	0.02	1 - 500	0.3	100
1,2-Dibromo-3-chloropropane	μg/L	0.02	1 - 500	0.2	100
1,2,4-Trichlorobenzene	μg/L	0.02	1 - 500	0.3	101
1,2,3-Trichlorobenzene	μg/L	0.02	1 - 500	0.3	100
1,3,5-Tribromobenzene	μg/L	0.04	1 - 500	0.3	101
1,2,4-Tribromobenzene	μg/L	0.04	1 - 500	0.3	101
Trichloroacetonitrile	μg/L	0.01	10 - 5000	0.8	97.9
Dichloroacetonitrile	μg/L	0.01	10 - 5000	12.7	112
Chloral hydrate	μg/L	0.01	10 - 5000	3.5	100
Chloropicrin	μg/L	0.01	10 - 5000	1.7	95.9
Bromochloroacetonitrile	μg/L	0.01	10 - 5000	1.5	101
Dibromoacetonitrile	μg/L	0.01	10 - 5000	1.6	102
Monochloroacetic acid	μg/L	0.24	6 - 600	2.1	103
Monobromoacetic acid	μg/L	0.04	4 - 400	0.9	96.5
Dichloroacetic acid	μg/L	0.02	6 - 600	0.5	92.5
Dalapon	μg/L	0.04	4 - 400	0.8	96.7
Trichloroacetic acid	μg/L	0.02	2 - 200	1.6	90.9
Bromochloroacetic acid	μg/L	0.02	4 - 400	4.1	89.0
Dibromoacetic acid	μg/L	0.01	2 - 200	1.1	90.7
Bromodichloroacetic acid	μg/L	0.03	4 - 400	2.9	88.5
Tribromoacetic acid	μg/L	0.24	20 - 2000	3.9	96.5
2-Chlorophenol	μg/L	0.04	0.50 - 50.0	4.7	89.9
3-Chlorophenol	μg/L	0.04	0.50 - 50.0	6.7	93.7
4-Chlorophenol	μg/L	0.04	0.50 - 50.0	7.0	97.0
2,6-Dichlorophenol	μg/L	0.07	0.50 - 50.0	4.4	89.0
2,5-Dichlorophenol	μg/L	0.09	0.50 - 50.0	6.0	90.6
2,4-Dichlorophenol	μg/L	0.05	0.50 - 50.0	6.0	94.3
3,5-Dichlorophenol	μg/L	0.03	0.50 - 50.0	6.1	93.2
2,3-Dichlorophenol	μg/L	0.07	0.50 - 50.0	6.6	93.3
3,4-Dichlorophenol	μg/L	0.03	0.50 - 50.0	7.0	98.2

2,4,6-Trichlorophenol	μg/L	0.04	0.50 - 50.0	6.2	91.4
2,3,6-Trichlorophenol	μg/L	0.03	0.50 - 50.0	7.5	90.5
2,4,5-Trichlorophenol	μg/L	0.04	0.50 - 50.0	7.0	93.0
2,3,5-Trichlorophenol	μg/L	0.03	0.50 - 50.0	6.9	94.1
3,4,5-Trichlorophenol	μg/L	0.15	0.50 - 50.0	6.5	109
2,3,4-Trichlorophenol	μg/L	0.03	0.50 - 50.0	5.0	93.4
2,3,5,6-Tetrachlorophenol	μg/L	0.05	0.50 - 50.0	12.6	91.1
2,3,4,6-Tetrachlorophenol	μg/L	0.10	0.50 - 50.0	11.9	90.1
2,3,4,5-Tetrachlorophenol	μg/L	0.12	0.50 - 50.0	10.8	93.5
Pentachlorophenol	μg/L	0.06	0.50 - 50.0	5.5	96.5
2,6-Dibromophenol	μg/L	0.04	0.50 - 50.0	6.1	87.0
2,4-Dibromophenol	μg/L	0.10	0.50 - 50.0	8.2	95.9
2,4,6-Tribromphenol	μg/L	0.13	0.50 - 50.0	12.7	93.8
Density	g/cm^3	0.0001	0.8 - 1.3	NA	NA

1) The method detection limit is determined as a one-sided 99% confidence interval from repeated measurements of a lowest-level standard across several calibration curves, and as a data from manufacturer. or Detection limit was calculated value that S × 3.14.

2) Calibration Range =

- Initial calibration should be conducted with at least five different concentrations of target analytical standard (eg. 1, 5, 10, 20, 40)
- If response factors or correlation factors are used, relative standard deviation (RSD) of each analyte should be ≤ 20 %
- If the linear regression method is used, correlation coefficient should be > 0.99

3) Precision is estimated as the percent relative standard deviation of repeated measurement (7 times) at the low constant concentration.
Precision (%) = RSD = S/x × 100 ; x : Mean measured value, S : standard deviation

4) Accuracy is estimated as the difference between the measured and target values of performance evaluation samples at the lower concentration range, and as the percent difference at the higher concentration range.
Accuracy (%) = x/x_i × 100 ; x_i : Certified or theoretical value, x : Mean measured value

5) NA : Not available.

If necessary, each test day, water quality meters will be pre-calibrated prior to the commencement of field activities in accordance with manufacturer' instruction.

Appendix 7.3. Raw data of method detection limit, Precision and Accuracy calculation for

- Chlorate
- Bromate
- Bromide
- TOC(DOC/POC)
- VOCs/THMs
- HANs(Haloacetonitriles)
- HAAs(Haloacetic acids)
- Halogenated Phenols

1.5 Training and Certification

1.5.1 Collection and Handling of Samples

Collection and handling of field samples from the “BioViolet™” BWM System as land-based test is undertaken by a joint team from the KOMERI and KTR, using standard water sample collection methods and in accordance with the ISO 5667-3 : Water quality -- Sampling -- Part 3: Guidance on the preservation and handling of water samples and specification of individually test method.

1.5.2 Laboratory Testing and Analysis

Name : Sun-Chool, Hwang
Study Director ; Data management and sample analysis, overall sample processing and Laboratory maintenance in accordance with KOLAS KS ISO/IEC 17025 regulation.
- Bromate
- AOX

Name : Young-Keun, Im,
Field Sampling Manager
- Density
- TRO/FRO
- O_3, ClO_2
- Bromide, ClO_3

Name : Ji-Hyun, Lee
Laboratory technician
- VOCs/THMs

Name : Jin-Hoon, Do
Laboratory technician
- DOC/POC
- HAAs

Name : Jun-Ho, Park
Laboratory technician
- HANs
- Halogenated Phenols

1.6 Documentation and Records

1.6.1 QAPP

Documentation and Records

The master copy of the QAPP is kept as a hard copy on file no. [BioViolet Land-based test] and as an electronic copy at file directory [Z:\BioViolet BWMS] on the main computer server of Kwang San Co. Ltd., at 1173-2, Jisa-dong, Gangseo-gu, Busan, Republic of Korea.

The project manager at Kwang San Co. Ltd., Young-Woo Lee, is the overall quality manager for this QAPP and has responsibility for controlling its currency and ensuring that all personnel listed in section 1.2 have up-to-date, controlled copies of the document, sent by email as a read only (non-changeable) PDF file. A record of distribution is to be kept as a hard copy on file no. [BioViolet Land-based test] and saved as an electronic copy at file directory [Z:\BioViolet BWMS] on the main computer server of Kwang San Co. Ltd.

All personnel listed in section 1.2 are to confirm by email to the project/quality manager when they receive the QAPP, including any updated versions. Such confirmation e-mails are to be printed and filed as a hard copy on file no. [BioViolet Land-based test] and saved as an electronic copy at file directory [Z:\BioViolet BWMS] on the main computer server of Kwang San Co. Ltd., at 1173-2, Jisa-dong, Gangseo-gu, Busan, Republic of Korea.

Weekly and/or monthly project progress meetings of the team leaders of each group involved in the G8 testing are to be held at the KOMERI Bio-Environment Team, and any suggested changes/updates to the QAPP made at those meetings are to be fully minuted.

The quality manager will then ensure that the updated QAPP is distributed to all personnel listed in section 1.2, again by email as a read only (non-changeable) PDF file, and that the record of distribution is completed. Personnel are to confirm by e-mail to the project/quality manager when they receive updated versions of the QAPP, which are to be filed as per paragraph.

“BioViolet™”

The QAPP Document Control Process is shown Figure 4.

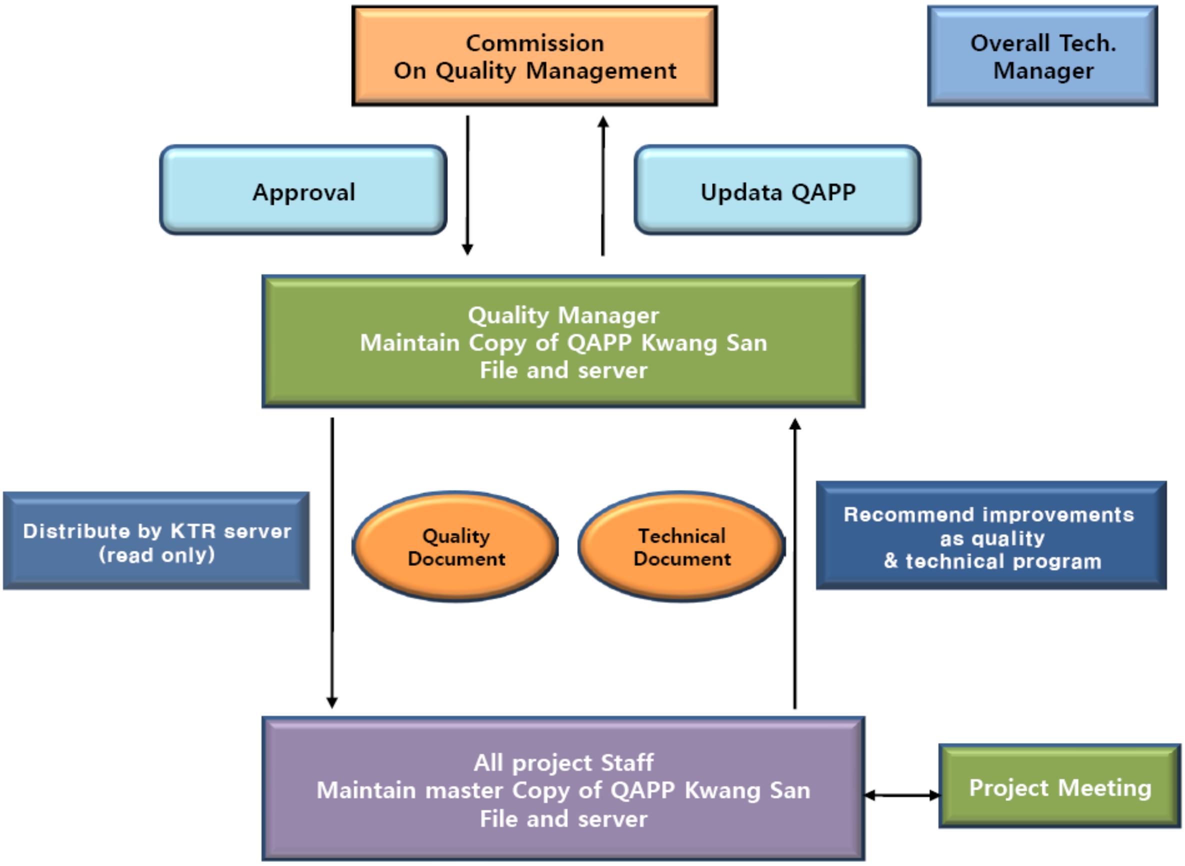

Figure 4. The QAPP Document Control Process

1.6.2 Chain of Custody Records

All record are investigated, approved, and kept in specified forms by those who are responsible and competence for all project documents and records. For any data stored electronically, backup procedures, access protocol, data retrieval, and photocopying of information archives should be recorded and kept. Retention and final disposition of some records may be regulated, as well as access to this information.

Summarize the information to be included in the project data package and its format. This might include :

- sampling collection and handling records such as field notebooks or operational records, chain-of- custody forms, sample receipt records, including sample tags and shipping bills ;
- Description of how the most current approved QA Project Plan will be distributed to project staff
- Information on the final disposition of records and documents, including location and retention schedule
- Analytical log books ;
- Test method raw data and QC sample records ;
- Standard Reference Material and/or proficiency test sample data ;
- Instrument, equipment, and model calibration information

Table 3. Sampling Record

<table>
<tr><td colspan="6" rowspan="2">Sampling Records</td><td>Tech. director</td></tr>
<tr><td></td></tr>
<tr><td>Receipt No.</td><td colspan="2"></td><td>Address</td><td colspan="3"></td></tr>
<tr><td>Receipt Date</td><td colspan="2"></td><td>Manufacturer</td><td colspan="3"></td></tr>
<tr><td>Item</td><td colspan="2"></td><td>Sampling Place</td><td colspan="3"></td></tr>
<tr><td>Lot. No.</td><td colspan="2"></td><td>Sampling Date</td><td colspan="3"></td></tr>
<tr><td>Sampling Method</td><td colspan="2"></td><td>Operator of sampling</td><td colspan="3"></td></tr>
<tr><td>Test item</td><td>environment condition</td><td colspan="2">Applied conditions</td><td>The number of Sample</td><td colspan="2">Data/Remark</td></tr>
<tr><td></td><td rowspan="4">Weather
Sunny, Cloudy, Rainy

Atmospheric temp.
˚C
Sample temp.
˚C
Humidity
%
Atmospheric pressure
mbar</td><td colspan="2"></td><td></td><td colspan="2"></td></tr>
<tr><td></td><td colspan="2"></td><td></td><td colspan="2"></td></tr>
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<tr><td>Name</td><td colspan="3">(sign)</td></tr>
<tr><td rowspan="2">Analyst</td><td></td><td></td><td></td><td></td></tr>
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1.6.3 Laboratory Raw Data Records

All laboratory raw data is saved in KTR server and test note.

2. Measurement and Data acquisition

2.1 Sampling Process Design

Before sampling, Sampling Manager should prepare sampling bottle, sampling record and Test request. (Table 3, Table 5). Also check list (Table 4) must be prepared before sampling.

Table 4. Check List of Sampling

Check list

	Item	No.	Use	Remark
1	Vial 40 mL(or 500 mL Brown G)	2 ea	with label	VOCs/THMs
	Bottle 100 mL(PE)	2 ea	with label	BrO_3^-, DOC/POC
	Bottle 500 mL(G)	2 ea	with label	AOX/HAA+HAN
	Bottle 2 L(Brown G)	1 ea	with label	Halogenated Phenols
	Bottle 1 L(Brown G)	1 ea	with label	Br^-/Spare
2	2 L Beaker(PP, handle)	2 ea		
3	10 L Vessel	1 ea		
4	20 L Vessel	1 ea		
5	D.W. Bottle	1 ea		
6	D.W. 20 L	-		
7	Disposable pipette	1 box		
8	Lab tissue	1 box		
9	Laboratory film (Parafilm)	1 roll		
10	Label pen/knife	some		
11	Detector set	1 set		
12	FRO set	1 set		
13	Auto-analyzer	2 sets		
14	S^{-2} kit	1 set		
15	Density meter	1 ea		
16	1, 5 mL Micropipette	Each 1 ea	with Tip	
17	200 mL Mass cylinder	1 ea		
18	250 mL Beaker	2 ea		
19	5, 10 mL pipette	Each 10 ea		
20	Pipette Feller	1 ea		

21	500 mL Mass cylinder	1 ea		
22	50 mL Burette	2 ea		
23	Sodium thiosulfate	1 L	0.025 N	
24	Starch	100 mL		
25	o-Toluidine	1 L		
26	Iodine STD	1 L	0.01 N	
27	Record	1 ea		
28	Ice box	5 box		
29	Ice	-		
30	Power leader	1 ea		
31	Microfilter	1 box		
32	10 mL Syringe	1 ea		
33	Burette stand	1 ea		

Table 5. Test Request

Test Request

	Person in charge	Tech. director
Sign		

TB -

Receipt ID	:	Address	:
Receipt date	:	Officer	:
Issue date	:	Company	:
Concerned team	:	Name	: / sign
Language	: English/Korean	Tel.	: Fax :
After Analysis	: keeping/waste	E. mail	: C.P. :
Transfer mode	: post/direct/Fax/E. mail	Billed company	:
Use of test record	: Quality control/	Sample Name	:

Test Item	Condition	Number of sample	Fee

Total item

Discount

Total item (Except Discount)

Base fee

Sample treatment fee

Copy No. of record

Record sending fee

Total : :

Sample Information	Product company		Trade Name	
Information	Caution		Aim of analysis	
Information	Specified content & Modification content			

Consulter	:	(sign)	Issue	:	(sign)
Receipt person	:	(sign)	underwriting	:	(sign)

As above, We request analysis

K T R

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2.2 Sampling Process Methods

Basic sampling methods was as follows (Table 6)

Table 6. Basic sampling methods

Item	Test Method	Remark
TRO/FRO	ISO 7393-2 : 1985	
Chlorate/ Bromide	US EPA 300.1 : 1997	
Bromate	ISO 15061 : 2001	
AOX	ISO 9562 : 2004	
DOC/POC	ISO 8245 : 1999	
Density	ISO 15212-1 : 1998 Oscillation-type density meters-Part 1	
VOCs/THMs	US EPA 524.2 : 1995	
HANs	US EPA 551.1 : 1995	
HAAs	US EPA 552.2 : 1995	
Halogenated Phenols	US EPA 8041A : 2007	

2.2.1 Sample Collection, Preparation, Decontamination Procedure

After sampling, immediately label (Table 7) attach in the bottle.

Table 7. Sample label sheet

시 료 확 인 표 (Label of sample identification)			
접 수 번 호 (Receipt No.)		접 수 일 자 (Receipt No.)	
발급예정일자 (Expected date of Issue)			
품 목 명 (Sample Name)			
시 료 구 분 (Sample classification)		상 담 자 (Consultor)	
주 무 부 서 (Concerned department)			

※반드시 의뢰 품에 부착
(Form must be Attached to sample)

바코드 표시
(Bar code)

2.2.2 Sampling Equipment, Preservation, and Holding Times

- Bromate

Sampling and storage of samples in glass bottles is preferable. Add 1.0 mL Ethylenediamine solution/1 L sample. If analysis cannot be performed within 2 hr from time of sampling, samples should be kept cool (4 ˚C).

- AOX

Filter sample containing particles through a filtration apparatus with a pore width of 0.45 μm. Acidify to between pH 1 to pH 2 with HCl and cool to between - 1 ˚C to 5 ˚C, for 2 weeks.

- DOC/POC

Because of the possibility of oxidation or bacterial decomposition of some components of aqueous ampoules, the time between sample collection and the start of analysis should be minimized. Also, samples should be kept cool (4 ˚C) and protected from sunlight and atmospheric oxygen. In instances where analysis cannot be performed within 2 hr from time of sampling, the sample is acidified (pH < 2) with HCl or H_2SO_4.(7 days, ISO 5667-3)

- VOCs/THMs

Collect the sample normally by immersion, by filling the bottle or the vial completely, discarding this water, refilling and stoppering so as to leave no headspace. Loss of volatile compounds through degassing of the sample should be avoided. Slowly fill the bottle at the sampling point until it overflows, avoiding turbulence.
If reaction between free halogens and organic matter in the sample, to produce trihalogenated methanes, is to be eliminated, add an excess of sodium thiosulfate to the sampling bottle or vial after rinsing the bottle or the vial but prior to sampling.(0.1 - 0.2 mL of 30 g/L solution)

- HANs/HAAs

Sampling and storage of samples in glass bottles is preferable. Add 10 mg ammonium chloride and 1 - 2 drop 6 N hydrochloric acid solution/1 L sample. If analysis cannot be performed within 2 hr from time of sampling, samples should be kept cool (4 ˚C). The samples are stable for at least 14 days.

- Halogenated Phenols

Acidify to 2 mL H_2SO_4/1 L(pH < 2) sample and cool to between 1 ˚C to 5 ˚C, 2 days.

2.2.3 Sampling/Measurement System Failure Response and Corrective Action Process

In case of failure, KTR will conduct a retest in accordance with KOMERI's contract.

2.3 Sample Handling and Custody

A procedure will be developed to collect, transport and store the samples for analysis that will minimize the possibility of contamination of introduction of artifacts. Special care will be taken to prevent the volatilization while filtering sample, prevent temperature damaging from water sample, as well as to prevent contamination of collected samples from the ubiquitous gaseous air pollutants.
Specific procedures to ensure the integrity of the collected samples will be outlined in the SOPs developed for each test method. However, at a minimum these will include the necessary procedures for ensuring sample validity during :

• preparation of sampling material, including procedures to clean water sample, loading water sample into sampling apparatus, and transport of sampling media to field locations

• Storage of sampling media once removed from sampling location including sealing procedures and temperature requirements for transportation from field locations to laboratory

• Archiving of sampling material until the analysis can be performed including restrictions of photochemical decomposition and temperature requirements

• Requirements for removing samples from archive for analysis that preserve sample integrity

Sample custody will be documented with sample record for each sample that will track from preparation and cleaning, deployment to the field location, sampling including verification of sample operation, retrieval, laboratory achieving until analysis, analysis and reporting.

The transport of all ballast water samples from field sampling to the laboratory for analysis is to be necessary, Fig. 6 shows custody for sample (KTR Procedure QP-06)

"BioViolet^{TM}"

Step	Responsible	Activities
Client (KOMERI/ Kwang San)		
↓		
Receipt		1. Making out of a letter of application 2. Preparation of Sampling record 3. Label of sample identification printing 4. Preparation of Check list 5. Car preparation for sample transfer
↓		
Sampling		1. Sampling and KOMERI identification 2. Sticking of sample label
↓		
Sample transfer (Site → KTR)		1. Transfer to analyst (identification)
↓		
Testing		1. Testing 2. Result & KTR server input
↓		
Input of data	(Analyst)	1. Testing 2. Data calculation & data input in KTR server
↓		
Identification of test report	(Testing Team)	1. Registration for test result 2. Approval of Technical Manager
↓		
Issue of test report	(Ulsan Administration Team)	1. Sign of director 2. Issue of test result (Post, Fax, E. mail)
↓		
Test report keeping	(Testing Team)	1. keeping (4 years)

Figure 6. Flow chart of sample custody

2.3.1 Sampling Tracking

The Laboratory Manager prepares a tracking sheet that includes all analytes and holding times for each project. A sample tracking sheet is started for each project to track all analyses for each sample. Dates when each preparation or analysis step is completed are added to the sheet, so each sample can be monitored to assure that holding times are being met for each analyte. The holding time is the time between sample collection and analysis, and is usually established by test method.

2.4 Analytical Methods

:

Appendix 3.4.2 : SOP of Test Methods

- Chlorate
- Bromate
- Bromide
- AOX
- TOC(DOC/POC)
- VOCs/THMs
- HANs
- HAAs
- Halogenated Phenols

2.5 Quality Control Procedures

2.5.1 Plan establishment

In the beginning of the year, Quality control procedures plan will be established with internal policy and plan schedule, refer to received document and on-line data.
Quality assurance plan establishment include as fallow, but surely no limit.

(1) Use of CRM (Certified standard materials) and 2st standard material
(2) Proficiency participation or comparison with other laboratory
(3) Reiteration test for one sample or other method
(4) Again test for stored samples
(5) Correlation for other specific result in same sample

2.5.2 Action

In accordance with Quality assurance plan, will be executed, their result reported. Study for Quality assurance result as fallow statistics treatment standard procedures (KTR QI-002).

2.5.3 Post-action

If the result of quality assurance is appropriate, test result approval should be given at the end of the quality assurance procedures. However, if the result is inappropriate or uncertain, suitable correction and preventive actions should be conducted according to Corrective & Preventive Action Procedure (KTR QP-11).

2.6 Data Acquisition

Accuracy of laboratory analysis will be assessed for compliance with the criteria established in 3 of the QAPP.

2.7 Data Management

2.7.1 Data Recording

Data that is transposed from field notebooks to an electronic database, and from laboratory reports to an electronic database, will be checked 100 % after transcription (Fig. 6)

2.7.2 Data Validation

Detail the process of data validation to insure that the system performs the intended function consistently, reliable, and accurately in generating the data.

2.7.3 Data Transformation

It is expected that data transformations made during this investigation will be relatively simplistic and all calculations made during data transformation will be checked 100 % prior to dissemination of the transformed information.

2.7.4 Data Transmittal

During the transfer of data from one place (field notebook or data report) to another (electronic data spreadsheet) the data will be copied and checked by one individual and then checked 100 % by a second individual to insure accuracy.

2.7.5 Data Reduction

Raw data from field measurements will be recorded directly in sample record. If errors are made, results will be legibly crossed out, initiated and dated by the person recording the data, and corrected in a space adjacent to the original entry. Logbooks will be periodically reviewed by the Project Management to insure that records are complete, accurate, and legible. Reduction of current water quality test data will be made by entering all field collected data in KTR server spreadsheet.

Laboratory data reduction procedures will be performed according to the following protocol.

All information related to analysis will be documented in controlled laboratory logbooks, instrument printout, or other approved forms. All entries that are not generated by an automated data system will be made neatly and legibly in waterproof ink. Corrections will be made by drawing a single red line through the error and entering the correct information adjacent to the cross out. All changes will be initialed, dated, and if appropriate, accompanied by a brief explanation. Analytical laboratory records will be reviewed by the Section Supervisors on a regular basis and by the Laboratory QA/QC Officer periodically, to verify adherences to documentation requirements.

Prior be being released as final, laboratory data will proceed through a tiered review process.
Each analyst will be responsible for reviewing the analytical and QC data that he has generated. As part of this review, the analyst will verify that :

- The appropriate methodology was used,
- Instrumentation was functioning properly,
- QC analyses were performed at the proper frequency and the analyses met the acceptance criteria,
- Samples were analyzed within holding times,
- All analysis were quantified within the calibration range,
- Matrix interference problems were confirmed,
- Method-specific analytical requirements were met, and
- Calculations, dilution factors, and detection limits were verified. Prior to releasing the final data, the Section Supervisor will review the data to :
- Verify the appropriate methodology was used,
- Verify QC analyses were performed at the proper frequency and the analyses met the acceptance criteria,
- Verify samples were analyzed within holding times,
- Review and document problems encountered during the analysis

The final data report will be reviewed and approved by Laboratory QA/QC Officer, Laboratory Project Manager, or Laboratory Manager prior to its release.

2.7.6 Data Analysis

The data generated during initial test periods in this project will be used to calculate the efficiency of ballast water treatment system during the test periods.

2.7.7 Data Tracking

Data will be recorded in the field notebooks and upon return completion of the associated data collection information will be transposed to an electronic spreadsheet format. Copies of field data will be made and stored in project file on a daily basis. Laboratory data will also be transposed to an electronic spreadsheet format upon receipt.

2.7.8 Data Storage and Retrieval

Data will be maintained in electronic Form using KTR server for data analyses and presentation purpose.

3. Assessment/Oversight

3.1 Assessments and Corrective Actions

The laboratory as part of their QA program will conduct laboratory performance and system audits. System audits will be done on an annual basis, at a minimum and will include an examination of laboratory documentation on sample receipt/log-in/storage/chain-of-custody, procedures, sample preparation and analysis, instrument operating records, etc.

Field audits will include examination of field sampling records/screening results/instrument operating records, sample collection, handling, and packaging in compliance with the established procedures, maintenance of QA procedures, chain-of-custody, etc. Follow-up audits will be conducted to correct deficiencies, and to verify that QA procedures are maintained through the investigation. The audits will involve review if field measurement records, instrumentation calibration records, and sample documentation.

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or out-of-limit QC performance that can affect data quality. Corrective action can occur during field activities, laboratory analyses, data validation, and data assessment. Corrective action should only be implemented after approval by the Project Manager, or his designee.
For noncompliance problems, a formal corrective action program will be determined and implemented at the time the problem is identified. The person who identifies the problem is responsible for notifying the Project Manager.

3.2 Reports to Management

Identify the frequency and distribution of reports issued to inform management of the project status ; for examples, reports on the results of performance evaluations and system audits ; results of periodic data quality assessments ; and significant quality assurance Final problems and recommended solutions. Identify the preparer and the recipients of the reports, and any specific actions recipients are expected to take as a result of the reports.

4. Data validation and usability

4.1 Data Review, Validation, and Verification

4.1.1 Sampling Design

Sample collection plans will be developed and used during the sample collection periods. These plans will include a detained figure of the sample location(offered by KOMERI), and the types of samples to be collected. The project manager will develop the sample collection plan and brief the sample collection team on the objectives of the sampling.

4.1.2 Calibration

Suspect calibration information will be highlighted in the sample record upon discovery of the information. Data collected during the period of suspect information will be footnoted as being questionable.

4.1.3 Data Reduction and Processing

Once these goals and objectives are evaluated and approved the "BioViolet™" BWM System, analytical data quality will be assessed to determine if the objectives have been met. In addition, the data will be reviewed by KTR's Quality Assurance Officer for indication of interference to results caused by sample matrices, cross contamination during sampling, cross contamination in the laboratory, and sample preservation and storage anomalies.

When client request treatment for incongruity test, KTR-Yeongnam staff notified to Quality Manager with investigation and discussion for its incongruity. Immediately, Quality Manager investigate, with support technical manager, evaluate for degree of importance.
If it was high concern incongruity

(1) Quality manager determine action As, discussion/meeting of Quality Management Committee
(2) Technical Manager be enforced corrective action in accordance with decision
(3) Under approval for director, will again begin analysis action

4.2 Validation and Verification Methods

In "BioViolet™" BWM System for water chemical test, test methods were applied ISO, ASTM, Standard method, OECD Guideline.

5. Reference

1. US EPA Requirements for Quality Assurance Project Plans, US EPA QA/R-5
2. US EPA Requirements for Quality Assurance Project Plans, US EPA QA/G-5
3. KOMERI QAPP, May, 2008
4. KTR KOLAS Manual, Procedure and direction documents, 2009
5. ISO/IEC 17025 : 2005, General requirements for the competence of testing and calibration laboratories
6. ISO 5667-3 : Water quality -- Sampling -- Part 3: Guidance on the preservation and handling of water samples
7. ISO 7393-2 : 1985 Water quality -- Determination of free chlorine and total chlorine – Part 2: Colorimetric method using N,N-diethyl-1,4-phenylenediamine, for routine control purposes
8. US EPA 300.1 : 1997, Determination of inorganic anions in drinking water by ion chromatography
9. ISO 15061 : 2001, Water quality – Determination of dissolved bromate – Method by liquid chromatography of ions
10. ISO 9562 : 2004, Water quality -- Determination of absorbable organically bound halogens (AOX)
11. ISO 8245 : 1999 Water quality-Guidelines for the determination of total organic carbon(TOC) and dissolved organic carbon(DOC)
12. ISO 15212-1 : 1998 Oscillation-type density meters -- Part 1: Laboratory instruments
13. US EPA 524.2 : 1995, Water quality -- Determination of highly volatile halogenated hydrocarbons – Gas-chromatographic methods
14. US EPA 551.1 : 1995, Chlorinated Compounds in Water Using GC-ECD
15. US EPA 552.3 : 1995, Haloacetic Acids and Dalapon in Drinking Water by Microextraction, Derivitization, and GC-ECD
16. US EPA 8041A : 2007, Phenols by gas chromatography
17. US EPA 330-5 : 1989, Total Residual Chlorine by Spectrophotometer
18. OECD TG 109 : 1996, Density of Liquids and Solids
19. US EPA 505.2 : 1997, volatile organic compounds in water by purge and trap capillary column gas chromatography with photoionization and electrolytic conductivity detectors in series
20. ISO 10304-1 : 2007 Water quality -- Determination of dissolved anions by liquid chromatography of ions – Part 1: Determination of bromide, chloride, fluoride, nitrate, nitrite, phosphate and sulfate
21. US EPA 330-3 : 1978 Chlorine, Total Residual (Titrimetric, Iodometric)

6. Appendix

Appendix 3.5.3. Certificate of Korea Laboratory Accreditation Scheme (KOLAS) ISO/IEC 17025, KT073